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Insights of Herbal Supplements during Transition Period in Dairy Animals: An Updated Review

Review Article

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ABSTRACT

There have been unsatisfactory results from antibiotic supplementation in long run for dairy animals. Antibiotic supplementation has been reported to accelerate the risk of antibiotic residues along with posing a potential threat to both human and animal health through compromised food safety. Therefore, there was a need of some alternative and safe supplementation to the dairy animals which may improve their production, reproduction, health, body condition, energy balance, and oxidative status. Herbal feed supplements are being widely used these days and scientists in the field of animal production are continuously devising the incorporation of some un-conventional herbal feed stuff in the diet of dairy animals. Herbal feed supplementation has been found comparatively much safer than any antibiotic or other inorganic feed supplements in farm animals. Transition management of dairy animals for improved post-partum performances has been a prime focus of most of the animal scientists. Transition period has far reaching effects on the post partum performances in regard to production, reproduction, health, body condition, energy balance, and oxidative status of dairy animals. Herbal supplements during transition period are anticipated to bring desired changes in the production, reproduction, health, body condition, energy balance, and oxidative status of dairy animals. Therefore, this review was framed with an aim of presenting a concise yet an informative discussion over the effects of supplementing herbal feed additives to the dairy animals to overview its effects on different production, reproduction and health parameters.

KEY WORDS dairy animals, health, herbal supplementation, production, reproduction, transition period.

INTRODUCTION

Dairy industry is now focussing more over the quality milk production which is safe for human consumption without any negative impact over the health and performances of dairy animals (Singh *et al.* 2020a; Singh *et al.* 2020d; Kansal *et al.* 2020). Improved dairy performance with maintenance of proper udder health has been the centre of attraction of many animal scientists since long time (Kumari *et al.* 2019; Kumari *et al.* 2020; Singh *et al.* 2020f). Proper management practices for animal husbandry may help in improving and maintaining the performances of dairy animals (Kumari *et al.* 2020; Singh *et al.* 2020a; Singh *et al.* 2020g). There have been detailed studies on the influence of antibiotics and hormonal treatments in farm animals during their transition period (Ludri *et al.* 1989; Singh and Ludri, 1994; Jyotsna and Singh, 2010; Singh *et al.* 2012; Mullen *et al.* 2014). However, it has also been remarked that prolonged utilization of antibiotics and hormonal treatments in farm animals to obtain improved milk

yield are associated with health problems like antibiotic residues and hormonal imbalances which leads to poor well being of farm animals (Grosvenor *et al.* 1993). Nevertheless, supplementation of herbal preparations emerged as useful and efficient possible substitute for use of antibiotics and hormones in dairy animals during late dry period and initial lactation period for desired production performances, reduced subclinical mastitis cases, with minimum negative energy balance in farm animals. It has been reported that there are more than 300 medicinal spices which have been identified in the world (Krishna *et al.* 2005; Pandey *et al.* 2005; Singh *et al.* 2012). Selection of suitable herbs for supplementing to the dairy animals has the potential of improving health and performances of farm animals as shown in Figure 1.

Management of dairy animals for the maintenance of their health during whole transition period has been seen to have far reaching effects on the lactation and health performances of dairy animals (Singh *et al.* 2020h; Singh *et al.* 2020i; Singh *et al.* 2020e). Transition period may be explained as last three weeks of dry period to three weeks post partum (Drackley, 1999; Overton and Waldron, 2004; Drackley and Cardoso, 2014). It is a common trend that high producing animals suffer negative energy balance wherein the nutrition requirement of animal escapes the supply of nutrients to the animals by decreased dry matter intake (Singh *et al.* 2020a; Singh *et al.* 2020b). McArt *et al.* (2013) remarked that the management strategies should be driven in such a way that it can suffice the nutrient availability to the animals to combat negative energy balance conditions. Combating negative energy balance in peripartum animals have shown improved production, reproduction, and health of dairy animals (Ospina *et al.* 2010; Chapinal *et al.* 2011; Chapinal *et al.* 2012; Singh, 2019; Singh *et al.* 2020a; Singh *et al.* 2020b). In recent past, dairy sector has experienced tremendous growth resulting in elevation of pressure for intense selection of dairy animals for higher production. This has led to higher incidences of metabolic disorders, and reduced reproductive performances in dairy herds. Excessive negative energy balance due to mobilization of nutrients during transition period is the main reason for most of the production loss and overall profitability of the dairy farms. Transition period (also termed as periparturient period) is the most crucial period in the life of a dairy cow. The period between 3 weeks before parturition to 3 weeks after parturition is considered as transition phase and is very much important for the production, and health status of the dairy cow. During this phase dairy cows are more susceptible for metabolic disorders, and infectious diseases (Drackley, 1999). As the cow changes from gestational non-lactating state to lactating state major nutritional, physiological, immunological, and metabolic changes occur during this phase (Sordillo and Raphael, 2013; Singh *et al.* 2020e; Singh *et al.* 2020i). The cow has to adjust rapidly to increased energy demands for milk production. Substantial amount of lipid is mobilized due to altered energy metabolism in this phase (Drackley, 1999) which might be accompanied by systemic inflammation (Trevisi *et al.* 2012). Alteration in redox balance has also been observed in early lactation due to metabolic changes occur during the transition phase (Bionaz *et al.* 2007; Singh *et al.* 2020c; Singh, 2021a). Recent studies (Koujalagi *et al.* 2018; Safari *et al.* 2018; Acharya *et al.* 2019; Gutiérrez *et al.* 2019; Kekana *et al.* 2020) shown that herbal supplementation during transition period may have beneficial effects for dairy animals and hence it may prove to be an important alternative for antibiotics and hormonal treatments for dairy animals (Ludri *et al.* 1989; Singh and Ludri, 1994; Jyotsna and Singh, 2010; Singh *et al.* 2012; Mullen *et al.* 2014).

It is a fact that there are several reviews on herbal feeding in dairy animals during lactation periods, however, there is scantiness of informative and yet a concise review paper on the supplementing herbal feeds or herbal preparations to the dairy animals during transition period to highlight its postpartum effects. Therefore, this review was specifically framed to present the insights of herbal feedings to dairy animals during transition period.

Mechanism of action of different compounds of herbs

Mode of actions of herbs supplemented to dairy animals have yet not been fully understood, however, different approaches have been tried to explain the mechanisms of action of such herbs or their bioactive compounds. Chemical compounds produced by herbs are arbitrarily divided into primary and secondary metabolites. Primary metabolites include sugars and fats, commonly found in all plants where as the secondary metabolites or phytochemicals are found in smaller range of plants, sometimes found only in a particular genus or species. These secondary metabolites are categorized into major group of chemicals such as essential oils, alkaloids, tannins, saponins, flavonoids, glycosides, amines and non-protein amino acids. Phytochemicals exert antimicrobial activity through different mechanisms.

Tannic acid present in tannins inhibit the growth of gut microbes such as *E. coli*, *Clostridium perfringens*, *Bacteroides fragilis* by deprivation of iron, hydrogen bonding and by non-specific interactions with vital proteins. Besides this, tannins bind to polysaccharides or enzyme promoting inactivation (Paiva *et al.* 2010). Alkaloid act by inhibition of topoisomerase and inhibit DNA synthesis (Karou *et al.* 2006). Saponin exhibits antimicrobial activity by forming complexes with sterols that are present in the membrane of micro-organisms.

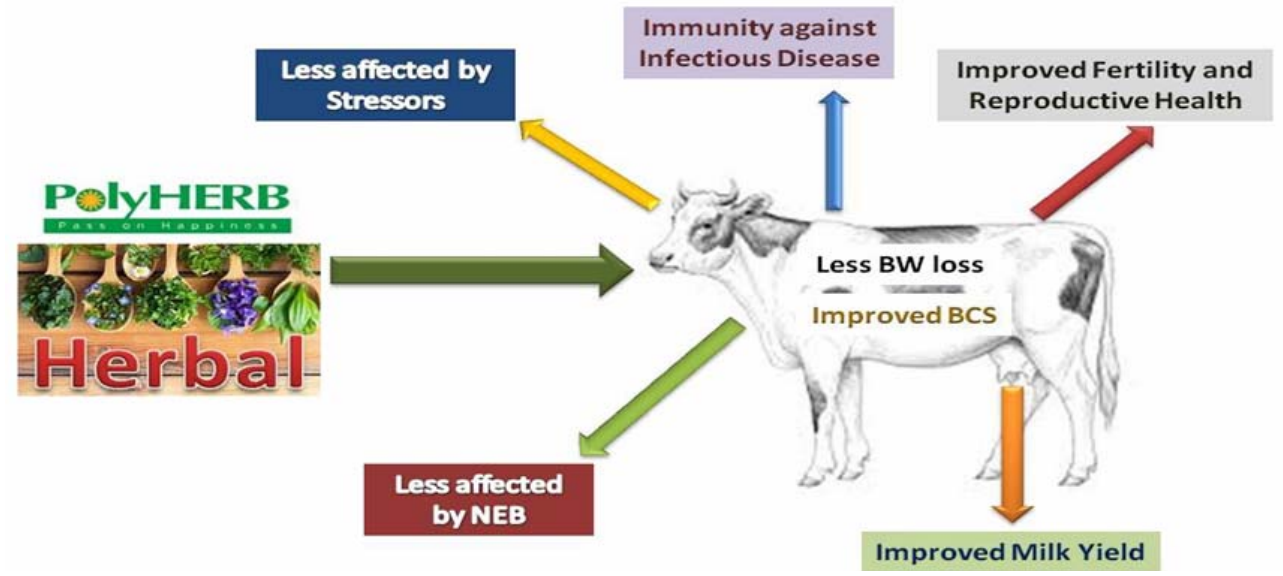

Figure 1 Potential benefits of herbal supplementation in transition dairy animals

These formations of complexes result in collapse of cells by damaging the membrane (Hashemi and Davoodi, 2011). Essential oils show antimicrobial activity against bacteria *E. coli* and *Clostridium perfringens* (Jamroz *et al.* 2005) but the exact mechanism is poorly understood. It may be due to lipophilic property of essential oil because the terpenoids and phenylpropanoids penetrate the membrane of pathogen and reach the inner part of cells to damage them (Bakkali *et al.* 2008) or it may be due to the chemical structure of essential oil such as presence of functional group and aromaticity. Flavonoids are polyphenolic phytochemicals having both bactericidal and bacteriostatic properties. They act by damaging cytoplasmic membrane, inhibiting energy metabolism and inhibiting nucleic acids synthesis in microorganisms (Ahmed *et al.* 2015).

Through beneficial actions of compounds of herbs on rumen and gut health, an improved immunity response is obtained in animals' body. Unwanted depletion of energy towards combating against the effects of invading microorganisms is relieved. Cell damage in animals' body is minimized through free radical scavenging action of constituents of herbs (Hashemi and Davoodi, 2011). It can be suggested that there may be no specific mode of action for herbal supplementation; instead, herbs have multi- dimensional beneficial effects in animals' body.

Effect of herbal feeding during transition phase on production performance

Transition period is very crucial in the life cycle of a dairy cow. During this phase cow require more energy to support the initiation of lactation; however it is challenging because of series of metabolic and physiological changes taking place in transition animals (Drackley, 1999). Overall reduction in feed intake was observed in animals prior to calving (Bertics *et al.* 1992; Drackley, 1999), and thereafter gradual increase in feed intake was observed in days following parturition (Osborne *et al.* 2002; Huzzey *et al.* 2005). The metabolic, nutritional, and physiological changes lead to negative energy balance in transition cows. Many researchers have tried different feed supplementation and feeding regimen to overcome the adverse effects of negative energy balance in transition cows. Poly-herbal mixtures are better alternatives for feed supplementation among various compounds employed to reduce the oxidative stress and to increase the production performance in transition animals (Koujalagi *et al.* 2018; Safari *et al.* 2018; Acharya *et al.* 2019; Gutiérrez *et al.* 2019; Kekana *et al.* 2020). Poly-herbal feed supplements are safe to use in animals to increase milk production.

Several physiological and metabolic changes occurring during periparturient period leads to reduction in dry matter intake and subsequent decline in milk production (Gross and Bruckmaier, 2019). Dietary supplementation of herbal plant mixture has positive effect of dry matter intake in periparturient period (Hashemzadeh-Cigari *et al.* 2015).

Some studies reported an enhancement of dry matter intake in animals supplemented with dietary pomegranate extracts. Pomegranate by-products are believed to be beneficial in terms of reducing methane production, degradation of ruminal protein, and enhancing propionic acid level (Safari *et al.* 2018). Body condition score (BCS) depicts the nutritional status of the animals and more loss of BCS is

observed immediately after calving owing to intensive mobilization of body reserves towards milk production (Hartwell *et al.* 2000). The change in body weight and change in BCS were significantly higher in control group of animals as compared to animals supplemented with pomegranate by-products during transition period (Safari *et al.* 2018).

Changes in BCS was lesser in transition animals fed with herbal mixture suggestive of feeding herbal mixture had beneficial effect on mobilization of body reserves (Hashemzadeh-Cigari *et al.* 2015).

The milk yield enhancing effect of Shatavari has been observed through many studies since a long time (Kumar *et al.* 2008). Patel and Kanitkar (1969) outlined that when of fresh root part of Shatavari was added to the concentrate feed in amount of ½ kilogram per day at milking time, it helps to enhance the milk yield markedly. Relatable results were documented in crossbred cattle in early lactation where feeding of grinded root of Shatavari at the rate of 100 grams every other day helped in substantial improvement in milk yield (Berhane and Singh, 2002).

Berhane (2000), observed that when Shatavari was added to the diet of freshly calved crossbred cows at the rate of 100 grams every other day, it helped to induce estrus in 100% of the cows as well as successful conception in 75% cows in the span of 3 months after calving.

Milk yield, 4% fat corrected milk and energy corrected milk were significantly higher in transition animals fed with rumen protected choline and green tea extracts (Acharya *et al.* 2020b). Higher milk production was observed in animals fed with herbal mixture during transition period (Hashemzadeh-Cigari *et al.* 2015). Although significant difference in milk efficiency (milk yield/dry matter intake) was not observed in animals fed with pomegranate by-products, fat corrected and energy corrected milk yield were significantly higher in animals fed with pomegranate by-products (Safari *et al.* 2018). An increase in daily average milk yield (by 12.76% over control group), and fat corrected milk yield (by 17.45% over control group) was observed in Murrah buffaloes by feeding poly-herbal mixture (poly-herbal mixture constituted of six herbs, Saunf (*Foeniculum vulgare*), 25 g; Ajwain (*Trachyspermum ammi*), 25 g; Methi (*Trigonella foenum-graecum*), 25 g; Sundh (*Zingiber officinale*), 25 g; Sowa (*Anethum graveolens*), 25 g and Cardamom (*Elettaria cardamomum*), 25 g with 25 gram black salt (Kala Namak) and administered in a single dose) along with butyrate in transition period (Chandra *et al.* 2017). The increase in milk yield is attributed to the galactopoietics and milk ejection property of poly-herbal mixture which enhances milk production and milk flow in lactating animals. Similarly, Singh *et al.* (2012) reported an increase of 0.526 kg/day milk yield in Murrah buffaloes supplemented with *Asparagus racemosus* root powder during transition period. Patel *et al.* (2013) also reported an increase in milk yield (by 14.2%) in Surti buffaloes by supplementing poly-herbal galactogogue mixture. Inclusion of *Scutellaria baicalensis*, a kind of fungus which has been traditionally utilised in Chinese medicines, extract in diet of early lactating animals has shown increase in overall milk yield in response to alteration of digestibility, and dynamics of rumen fermentation thereby increasing milk production (Olagaray *et al.* 2019). Increase in milk yield was observed in dairy animals by supplementing herbal choline, especially in first lactation (Gutiérrez *et al.* 2019). Feeding of concentrated pomegranate extract had significant effect on increasing milk yield in early lactation (Shabtay *et al.* 2012).

Milk fat content and total solids were higher in transition animals fed with poly-herbal mixture along with butyrate (Chandra *et al.* 2017). The higher amount of milk fat is attributed to better availability of butyrate (Thomas and Chamberlain, 1988) and lesser lipid mobilization in body of animals supplemented with poly-herbal mixture. Milk constituents such milk fat, milk solids-not-fat, and protein increased in transition cows supplemented with herbal vitamin E and selenium complex (Koujalagi *et al.* 2020). Dietary supplementation of rumen protected choline and green tea extracts enhanced milk fat and total solid contents transition Karan Fries cows (Acharya *et al.* 2020b). Rumen protected choline helps in more lipid mobilization towards mammary gland for synthesis of milk fat. Lactating animals supplemented with *Moringa oleifera* leaf meal have shown increase in milk fat (Kekana *et al.* 2020) owing to the stimulatory effect of *Moringa oleifera* on higher fiber digestibility and enhancement of acetate production in rumen (Khalel *et al.* 2014).

The energy status of the cows during pre-parturient period significantly affects the birth weight of calves. Higher birth weight of calves was observed in animals fed with poly-herbal mixture and butyric acid (Barjibhe *et al.* 2019). Lower amount of negative energy balance in animals fed with poly-herbal mixture reduces the level of insulin which in-turn has glucose sparing effect and this saved energy is deviated for the growth of fetus (Barjibhe *et al.* 2019).

Curvilinear increase ($P \leq 0.05$) in milk yield due to addition of cumin seed in the diet of dairy cows at 0, 100, 200 and 300 g/cow/d with values 47.9, 52.5, 55.1 and 53.6 kg/d respectively was observed by Ghafaria *et al.* (2017). Fat and 4% fat corrected milk yield were not affected by treatment, but all other milk components yield followed the same trend as that of milk yield ($P \leq 0.05$). Bipate and Mishra (2020) supplemented the poly herbal mixture prepared from 25g each of Ajwain (*Trachyspermum ammi*), Saunf (*Foeniculum vulgare*), Methi (*Trigonella foenum-*

graecum), Sowa (*Anethum graveolens*), Sundh (*Zingiber officinale*) and Cardamom (*Elettaria cardamomum*) in crossbred cows from the day of calving to 10 days postpartum. They reported average enhancement of 21.53% milk yield in treatment group compared to control (6.91%) from 0 to 60th day of lactation. Similarly, Japheth *et al.* (2019) was also observed increased average total milk in Murrah buffaloes (2642.87±75.45 kg) supplemented with polyherbal mixture as compared to the control group (2292.27±77.65 kg). Furthermore, proportion of animals suspicious for mastitis were also significantly decreased (P<0.05) in treatment group as that of control group. Supplementation of herbal preparation of galactogogue (*Sanjivani biokseera*) to Kankrej cows at 60 g/day from 4th day of calving for 1-month substantially increased (P<0.05) the average milk yield of 52 days in treatment group (9.34±0.21 L/day) as compared to the control group (7.75±0.26 L/day), without affecting the milk composition (Panchasara *et al.* 2019). Supplementation of Shatavari containing saponin and tannin at 50 to 100 g/day/animal significantly enhanced the milk production in buffaloes (Tanwar *et al.* 2008) and crossbred cows (Mirzaei, 2012). Similarly, significant increase (P<0.05) in milk production was recorded due to supplementation of Shatavari powder at 50 g/head/day for 90 days after parturition in lactating crossbred Sahiwal cows (Muwal *et al.* 2020).

Effect of herbal feeding during transition phase on antioxidant status

Due to increased lipid mobilization during transition period to combat the negative energy balance, the animals are more susceptible to oxidative stress, and inflammatory and immune dysfunction (Sordillo and Mavangira, 2014). These physiological alterations increase the risk of occurrence of metabolic and inflammatory diseases in transition animals. The antioxidants present in the circulatory systems plays a crucial role in maintaining the balance between damage due to oxidative stress and repairing of oxidative damage (Wang *et al.* 2019). Some of the antioxidants such as glutathione peroxidase, superoxide dismutase (SOD), catalase, glucose-6-phosphate, and glutathione reductase facilitates in the anti-oxidation activity against free radical damage caused by oxidative stress (Reyazuddin *et al.* 2014). Superoxide dismutase catalyses the conversion of superoxide moleculesinto hydrogen peroxide, which in-turn metabolized to water by glutathione peroxidase, and catalase.

Total antioxidant capacity was increased in animals supplemented with rumen protected choline (Salman *et al.* 2017) and green tea extracts (Acharya *et al.* 2019). Increased level of blood antioxidant status was observed in transition animals supplemented with rumen protected choline (Sun *et al.* 2016). The antioxidant capacity of green tea extracts is attributed to the epigallocatechin-3-gallate present in the green tea extracts (Saleh *et al.* 2014). Thiobarbituric acid reactive substance level was reduced significantly in transition animals supplemented with rumen protected choline and green tea extracts (Acharya *et al.* 2019) which is an indicative of lesser oxidative stress in transition animals. Oxidation and fatty acid mobilization was reduced in transition animals supplemented with pomegranate by-products indicated by reduced ß-hydroxy butyrate and free fatty acid levels (Safari *et al.* 2018). Polyphenolic compounds and conjugated fatty acids are responsible for the antioxidant property of the pomegranate by-products (Tzulker *et al.* 2007).

Transition cows supplemented with *Moringa oleifera* leaf meal shown significantly higher levels of superoxide dismutase, and catalase activity indicating enhanced antioxidant status (Kekana *et al.* 2020). Reduction in concentration of malondialdehyde (MDA) is suggestive of indicator to lipid peroxidation (Wang *et al.* 2019). Safari *et al.* (2018) reported an increase in antioxidant activity, and decrease in level of MDA (indicator of oxidative stress) in transition animals fed with pomegranate by-products, specifically pomegranate seed pulp. High polyphenol content present in *Moringa oleifera* leaf meal reduced MDA and increased the activity of glutathione peroxidase (Siddhuraju and Becker, 2003). Oxidative stress and lipid peroxidation was less in transition animals supplemented with herbal vitamin E and selenium complex (Koujalagi *et al.* 2020). In addition, feeding of herbal vitamin E and selenium complex has been observed to increase the level of antioxidants such as superoxide dismutase and reduced glutathione in transition animals. Supplementation of herbal choline (20 g per 100 kg body weight per day) along with herbal liver tonic (10 g per 100 kg body weight per day) has shown to reduce the oxidative stress in transition animals (Koujalagi *et al.* 2018).

Many studies done in India indicated that cumin oils exhibit high antioxidant activity due to presence of flavonoids especially apigenin and luteolin in cumin seeds (Patil *et al.* 2017; Leung, 1980). Gagandeep *et al.* (2003) showed that supplementation of cumin seed in mice diet at 2.5 and 5% of diet resulted in increased catalase, superoxide dismutase and decreased glutathione. Furthermore, glutathione reductase and glutathione peroxidase activities were not affected due to cumin supplementation. Juhaimi and Ghafoor (2013) confirmed that addition of extracts of cumin seed has enhanced DPPH (1,1-Diphenyl-2-Picrylhydrazyl) radical scavenging activities when compared to non supplemented animals and cumin seed extracts had antioxidant activity range from 8.25 to 11.24 mg/mL.

In both normal and immune suppressed animals, oral administration of cumin resulted in modulation of T-

lymphocyte's expression in a dose dependent manner. It also stimulated the expression of T-cell's (CD4 and CD8) and Th-1 cytokine's in cyclosporine-A induced immune suppressed mice and normal mice. The active component of cumin increased the level of depleted T-lymphocytes, reduced the increased corticosterone levels and adrenal glands size and increased the thymus and spleen weight in stress induced immune suppressed animals (Chauhan *et al.* 2010; Patil *et al.* 2017).

Effect of herbal feeding during transition phase on reproduction performance

Transition period is very challenging for the dairy cows as they undergo several environmental and managemental stresses. In addition, they have to cope with the metabolic, physiological, and endocrine changes happening in them during transition period. The resulted negative energy metabolism may reduce the reproductive efficiency through various biological mechanisms (Shabab *et al.* 2016).

In a multiyear evaluation by feeding herbal choline to dairy animals, Gutiérrez *et al.* (2019) reported an increase in fertility rate in first lactation animals and reduced cases of abortion. The occurrence of post-partum anestrous was less in animals fed with poly-herbal mixture during transition period (Chandra *et al.* 2019). Feeding of poly-herbal mixture during transitional period reduced the days to first observed heat (commencement of cyclicity) which might be due to early uterine involution and initiation of estrous in animals fed with herbal mixture (Barjibhe *et al.* 2019; Acharya *et al.* 2020a). Improved uterine health due to herbal feeding decreases the service period, and improves the conception rate (Barjibhe *et al.* 2019; Acharya *et al.* 2020a) and pregnancy rate (Acharya *et al.* 2020a).

There is a high chance of occurrence of reproductive disorders during transition period due to compromised immunity and negative energy balance. The incidences of reproductive disorders were low in transitional animals fed with herbal mixture (Barjibhe *et al.* 2019; Chandraet *et al.* 2019; Acharya *et al.* 2020a). The occurrence of metritis and endometritis were lower in animals supplemented with butyric acid and green tea extracts (Chandraet *et al.* 2019). Similarly, Acharya *et al.* (2020a) also observed lesser incidences of uterine infections in animals supplemented with rumen protected choline and green tea extracts during transition period. Anti-inflammatory action along with immunomodulation property of the herbal mixture was related to the lesser incidences of uterine infection in animals fed with herbal mixture.

Negative energy balance occur during transitional phase may delay the involution of uterus. The increased concentration of non-esterified fatty acids (NEFA) during transitional period alters the phagocytic activity of leukocytes thereby making the host more susceptible for uterine infections (Zerbe *et al.* 2000). Lower level of NEFA concentration was observed in transitional animals fed with poly-herbal mixture as compared to control group of animals (Barjibhe *et al.* 2019).

In addition, retained fetal membranes also delay the involution of uterus and predispose the animals for reproductive infections (Gröhn and Rajala-Schultz 2000). Retention of fetal membranes was lesser in animals fed with poly-herbal mixture during transition period (Ulfina *et al.* 2015; Barjibhe *et al.* 2019; Chandra *et al.* 2019; Acharya *et al.* 2020a) due to early detachment of placental membranes which might be attributed to the improved host immunity, antioxidant, and metabolic status of animals by feeding herbal mixture. Lower incidence of reproductive disorders in animals fed with poly-herbal mixture was thought to hasten the process of uterine involution.

Japheth *et al.* (2021) investigated the effect of supplementation poly-herbal mixture on reproductive performance in post- partum dairy buffaloes. They observed, significant increase ($P<0.05$) in the involution rate of cervix and uterus in treatment group, along with this, there was efficient cleansing of lochia. Days to first insemination, service period, and the number of services per conception was reduced in poly-herbal mixture supplemented group as compared to the control group. Number of buffaloes with large ovarian follicles within 28 days post- partum were substantially ($P<0.05$) higher in treatment group as compared to control group.

Chaudhiry *et al.* (2018) observed that supplementation of combination of *Tinospora cordifolia* and *Randia dumetorum* were effective in treatment of anoestrus buffalo heifers. Bipate and Mishra (2020) reported that supplementation of poly-herbal mixture to the crossbred cattle decreased the number of insemination per conception in treatment group (2.38) when compared with un-supplemented group (2.88). Apart from this, substantial reduction ($P<0.05$) in time required for of foetal membranes expulsion and no case of foetal membrane retention was recorded in treatment group as compared to control.

Muwal *et al.* (2020) reported that average first post-partum oestrus and service period was significantly reduced ($P<0.05$) due to supplementation of shatavari (*Asparagus racemosus*) powder at 50 g/head/day for 90 days after parturition in lactating crossbred Sahiwal cows (52.83±1.27 and 90.16±1.44 days) when compared to non supplemented group (77.50±2.50 and 112.50±2.50 days). Shatavari enhances antioxidant activity in the by surging the body levels of ascorbic acid, enzymes like superoxide dismutase and catalase (Bhatnagar *et al.* 2005).

Effect of herbal feeding during transition phase on udder health

Milk somatic cell count (SCC) is used to assess the quality of milk. Somatic cells are closely related to udder health and quality of milk. In general, somatic cells are secreted to eliminate udder infections and tissue damage during lactation (Hillerton, 1999). Reduction in immunity and other inflammatory conditions may lead to increase in milk SCC during initial stages of lactation (Acharya *et al.* 2019). The immuno-modulating and anti-inflammatory effect of the herbal feed supplements is thought to boost up the udder immunity thereby decreasing milk SCC (Acharya *et al.* 2019). Several researches have been conducted to estimate the effect of herbal feeding on udder health but least work has been done to assess its effect during transition period.

Feeding of plant additives containing choline can reduce the incidences of both clinical and subclinical mastitis (Gutiérrez *et al.* 2019). Acharya *et al.* (2019) reported decline in SCC by supplementing rumen protected choline and green tea extracts in transition period suggestive of positive effect of green tea extracts on immunity, and in addition rumen protected choline provides more methyl groups which will help in building polyamides, improving immunity, and repairing of tissue damage by reducing inflammatory reactions (Bindel *et al.* 2000). Feeding of poly-herbal mixture along with butyric acid improves the udder health status in transition cows. Significant decline in SCC is observed in animals supplemented with poly-herbal mixture and butyric acid as compared to non supplemented group (Chandra *et al.* 2017). Feeding of *Scutellaria baicalensis* extract during early lactation reduced milk somatic cells and also incidences of mastitis in dairy cows (Olagaray *et al.* 2019). Decline in incidence of mastitis was observed in dairy animals supplemented with herbal mixture (Hashemzadeh-Cigari *et al.* 2014), and reduction in milk somatic cells in lactating cows fed with *Moringa olifera* leaf meal (Kekana *et al.* 2019). Koujalagi *et al.* (2020) also reported decline in SCC in transition cows supplemented with herbal vitamin E and selenium complex. Shatavari can be helpful in preventing incidences of udder infection in dairy animals (Kumar *et al.* 2011). The alcoholic solution of shatavari root showed germicidal effect on prime mastitis causing microbes like coliform, pseudomonas, klebsiella and streptococci (Bhatnagar *et al.* 1961, Ahmad *et al.* 1998). Plasma level of haptoglobin is generally used as an indicator of systemic inflammation. Haptoglobin concentration in milk will be helpful in detecting clinical and subclinical mastitis (Thomas *et al.* 2015). Although higher concentration of haptoglobin was observed during first week after calving, supplementation of *Scutellaria baicalensis* extract had no significant effect on concentration of haptoglobin in milk (Olagaray *et al.* 2019).

Supplementation of herbal vitamin E and selenium complex could reduce the pH and electrical conductivity of milk by reducing seepage of sodium, chlorine, and immunoglobulins from blood to milk (Koujalagi *et al.* 2020). Feeding of herbal vitamin E has positive effect on the udder health by enhancing antioxidant activity and improving the shelf-life of milk by inhibiting auto-oxidation of milk.

CONCLUSION

Supplementation of herbal preparation to dairy animals has opened a safer window for dairy herdsman to obtain improved milk quality and quantity from dairy animals. Herbal supplementation is safer in the context that it does not have food safety issues for human health such as antibiotic residues and hormonal imbalances as in the cases of antibiotic or hormonal treatment to dairy animals achieving more milk from them. Transition period supplementation of herbal preparations to farm animals may have far reaching beneficial effects over their production, reproduction, and health performances of dairy animals through channelizing nutrients available to the animal's body thereby maintaining proper body condition and reduced negative energy balance during transition and initial lactation period. This review is anticipated to provide a basic and yet a concise and informative overview about herbal supplementation during transition period.

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